

APPLICATION FOR UNITED STATES LETTERS PATENT

FOR

COMPLETELY INTEGRATED HELMET CAMERA

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## COMPLETELY INTEGRATED HELMET CAMERA

### BACKGROUND OF THE INVENTION

#### 5 1. Field of the Invention

The present invention relates generally to image sensors, and in particular, relates to a complementary metal oxide semiconductor (CMOS) image sensor forming part of a camera unit that can be mounted onto headgear, such as sports helmets.

#### 10 2. Background Information

Sports video information of real-time events is a major part of modern-day America. Camera operators who photograph a sporting event and its live action are removed from participating directly on the field. Allowing a camera operator to physically interject onto the actual field of play creates a potential for camera operator or player injury, and interferes with the normal play of the sporting event.

20 Current systems for capturing video and still images of sporting events typically include video cameras positioned in various locations within the sporting arena, with the camera operators capturing video and still images from around the periphery of the sporting event (e.g., outside of the actual playing field).

25 However, placement of these cameras outside of the actual playing field has certain disadvantages. For instance, in order to get the "best" views of particular instances in the game, multiple cameras need to be positioned along the

periphery, so that the best angle or "shot" can be chosen from among the different cameras. This is cumbersome and expensive because of the extra equipment and set-up that are needed, and because of the high level of coordination required between camera operators, directors, technicians, etc.

5           Additionally, even though there may be multiple angles available from the cameras positioned around the periphery of the playing field, the "best" shot is sometimes simply not available. The camera with the best angle may be too far from the play, or spectators might obstruct the camera's view of the play, by players standing along the sideline, or by physical objects.

10           Furthermore, the cameras around the periphery of the playing field may be mounted on a fixed platform, and are therefore not portable to follow the players as they move up and down the field. If the cameras have to be mobile, then they are often carried on the shoulder of the camera operator walking along the sideline, or they are mounted on a moving stand or vehicle that moves along the  
15           sideline. Because of the weight and bulkiness of these conventional cameras and of their mounts/platforms, moving a camera to follow the action is difficult to perform with satisfactorily high quality results.

          Accordingly, there is a need to improve on the capturing of real-time video or still images of sporting events.

Non-limiting and non-exhaustive embodiments of the present invention will be described in the following figures, wherein like reference numerals refer to like parts throughout the various views unless otherwise specified.

Figure 2 shows a front view of an embodiment of the helmet-mounted camera unit of Figure 1.

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## DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Embodiments of an integrated helmet camera and associated helmet camera system are described in detail herein. In the following description, numerous specific details are provided, such as the components of a helmet in Figures 1 and 2, to provide a thorough understanding of embodiments of the invention. One skilled in the relevant art will recognize, however, that the invention can be practiced without one or more of the specific details, or with other methods, components, materials, etc. In other instances, well-known structures, materials, or operations are not shown or described in detail to avoid obscuring aspects of various embodiments of the invention.

Reference throughout this specification to “one embodiment” or “an embodiment” means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, the appearances of the phrases “in one embodiment” or “in an embodiment” in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments.

As discussed above, existing camera systems suffer from the disadvantages of being bulky and inconvenient to position for best camera angles. An embodiment of the invention addresses these disadvantages by physically attaching an unobtrusive camera unit of sufficiently small size and weight that is capable of broadcasting real-time video or still image data from a helmet. In one embodiment, the camera unit includes a small complementary metal oxide semiconductor (CMOS) camera sensor mounted directly on the front of a helmet,

such as a football helmet. Embodiments of the invention provide certain advantages, including minimizing size and weight, while still allowing video or still image capture to occur directly from a point of view that is close to that of the actual viewpoint of the wearer.

5 For simplicity of explanation, an embodiment of the invention will be described herein in the context of a camera unit mounted on a football helmet. It is to be appreciated, however, that other embodiments of the invention may provide camera units mounted on hockey helmets, baseball helmets, racing car driver helmets, motorcycle helmets, construction helmets, law enforcement helmets, or  
 10 other similar sports headwear or industrial headwear/headgear. Accordingly, the invention is not necessarily limited by the specific type of helmet utilized.

Referring first to Figure 1, shown generally at 10 is a helmet camera system according to an embodiment of the invention. The system 10 includes a helmet 12, which is a football helmet in the illustrated embodiment. The helmet 12  
 15 has a main body 14 to cover the head of the wearer, with the main body 14 having a front opening 16 to provide the wearing with a field of view (FOV). The opening 16 has a face mask 18, typically made of a metal material, such as steel, to protect the face of the wearer. The face mask 18 is mounted to the main body 14 by one or more attaching units 20. The attaching units 20 can include clips, bolts, rivets,  
 20 screws, or other similar devices.

In an embodiment of the invention, a completely integrated camera unit 22 (or "module") is mounted onto the helmet 12. The camera unit 22 is of small size and weight, and can be mounted on the face mask 18 at front portion of the main body 14, just above the opening 16. This position allows the camera unit 22 to  
 25 have substantially the same FOV as the wearer of the helmet 12. The camera unit 22 can be retrofitted onto existing commercially available helmets, or helmets can

be manufactured that include the camera unit 22. Specific components of the camera unit 22 are described later below with reference to Figures 2-4.

The camera unit 22 can be provided with a wireless communication link 24 to a remote station 26. The communication link 24 can comprise a radio frequency signal, infrared signal, microwave signal, optical signal, or other suitable wireless signal. The communication link 24 allows video and/or still images captured by the camera unit 22 to be transmitted to the remote station 26 for subsequent processing or broadcast. The communication link 24 also allows the remote station 26 to control various settings of the camera unit 22, as described below. The remote unit 26 can be any type of component or system remotely located from the camera unit 22, and can include, for example, a hand-held device positioned along the sideline of a playing field, a media center located in a vehicle in a parking lot or in a press box, a stationary transceiver positioned at a vantage point in a stadium/arena, etc.

Figure 2 shows a front view of the camera unit 22 mounted on the helmet 12. The camera unit 22 includes a substrate 28 onto which various electronic and nonelectronic components of the camera unit 22 can be mounted. In one embodiment, the substrate 28 can be just a solid, thin, and flat piece of material that functions simply as a platform to mount components of the camera unit 22. In another embodiment, the substrate 28 can form part of a housing that provides protective covering for electronic components of the camera unit 22. The camera unit 22 can be attached to the face mask 18 by a plurality of attaching units 30-32 which can include clips, bolts, rivets, screws, or other similar devices. In one embodiment, the attaching units 30-32 are attached to the substrate 28, and are similar to the attaching units 20 that attach the face mask 20 to the main body 14.

Thus, as with the face mask 18, the camera unit 22 can be easily attached and removed from the face mask 18 and/or from the main body 14.

The camera unit 22 includes a lens unit 34, behind which components such as color filters, an image sensor, associated electronic components, etc. can be located. An antenna unit 36 allows transmission/reception along the communication link 24. In one embodiment, the antenna unit 36 includes a metal lead 38 that is electronically attached to the face mask 18, thereby allowing the face mask 18 to function as an antenna to improve transmission and reception. In another embodiment, the antenna unit 36 can use (as an antenna) a metal lead 40 that is attached along the interior surface of the helmet 12 or that is made integral with the main body 14.

The camera unit 22 includes a power unit 42 that, in one embodiment, can use miniature-sized batteries of sufficient power that are mounted onto or adjacent to the substrate 28. In another embodiment, a larger-sized battery 46 can be used by suitably connecting the battery to the power unit 42 by a lead 44. The lead 44 can be attached along the interior surface of the main body 14, with the battery 46 also attached to the interior surface and occupying a space that does not obstruct the helmet wearer's head.

An adjusting unit 48 can be attached to the substrate 28, such that the "tilt" of the camera unit 22 can be adjusted. In this manner, the FOV of the camera unit 22 can be optimized for each individual helmet wearer. According to one embodiment and as shown in greater detail in Figure 3, the adjusting unit 48 allows the upper portion of the camera unit 22 to move forward or backward, while the lower portion can pivot on the face mask 18.

Figure 3 is a partial side view of the helmet 12 and camera unit 22, showing the mounting configuration in greater detail. As shown in the figure, the



substrate 28 can be positioned substantially flat against the front surface of the main body 14, just above the face mask 18. The clips 30-32 can attach the substrate 28 to the face mask 18 through the use of a plurality of members 52, such as screws, bolts, rivets, pins, etc. passing through holes in the clips 30-32 and in the substrate 28. The members 52 can in turn pass through holes in a label 50 (typically found on many football helmets). After passing through the label 50, the members 52 can be attached to, although it is not required, to the main body 14.

In one embodiment, the adjusting unit 48 can comprise a threaded bolt/screw that passes through a female clip disposed within the label 50. After passing through the label 50, the adjusting unit 48 can contact, although it is not required, the main body 14. Turning the adjusting unit 48 clockwise or counter-clockwise, therefore, results in positional change of the plane of the substrate 28, resulting in a change in FOV for the camera unit 22. In other embodiments, the adjusting unit 48 can include springs, clamps, or other such devices that are suitable to adjust a planar position of the substrate 28.

Figure 4 is a block diagram showing some of the components of the camera unit 22, symbolically shown as being provided with power via the power unit 42. In one embodiment, the components of the camera unit 22 can be contained on a single chip. The camera unit 22 includes an image sensor 54, which can be a single-chip color CMOS image sensor, such as those manufactured by Omnivision Technologies, Inc. of Sunnyvale, California, the assignee of the present invention. Such CMOS image sensors provide advantages over image sensors that use charge coupled devices (CCDs), in that CCD image sensors have large sizes and power consumption that are not well-suited for helmet-mounted camera units. The image sensor 54 includes a two-dimensional sensing array comprising a plurality of pixels (not shown), and associated electronics.

The image sensor 54 can include or can be coupled to a data, image, and signal processing unit 56. The processing unit 56 can comprise timing circuitry, analog-to-digital converters, calibration circuitry, control circuitry, image processing circuitry (such as chromaticity and luminance signal processing circuitry), etc. In one embodiment, the processing unit 56 can include a video timing generator to generate SYNC and BLANK signals (useable for vertical blanking intervals) for a National Television Standards Committee (NTSC) video format. The SYNC and BLANK signals, along with processed image signals, can then be directed to a NTSC encoder that is controllable by hue and saturation controls.

Other circuitry to generate composite video can be used. For example, circuitry of the camera unit 22 can be provided to generate Phase Alternating Line (PAL) or Systeme Electronique Couleur Avec Memoire (SECAM) video formats or to generate data in digital format. For the sake of simplicity, specific details of the image sensor 54 and of the processing unit 56 are not provided herein because such details would be known by those skilled in the art based on the discussion provided herein. Examples of suitable devices that can be used for the image sensor 54 and the processing unit 56 are disclosed in U.S. Patent Nos. 5,901,257 and 6,035,077, assigned to Omnivision Technologies and incorporated herein by reference.

Images captured by the camera unit 22 via the image sensor 54 and subsequently processed by the processing unit 56, are provided as signals to a transmit unit 58. The transmit unit 58 can include the antenna unit 36 and other components known in the art (e.g., a modulator) to transmit signals representative of these images to the remote station 26, via the communication link 24. After receiving these signals transmitted from the transmit unit 58, the remote station 26 can perform further processing (e.g., demodulation, filtering, enhancement, etc.), in

order to re-transmit the signal or to save the signal in a storage medium (e.g., a video cassette, disk, compact disk, digital video disk, etc.).

The remote station 26 can further remotely control settings of the camera unit 22, via control signals sent along the communication link 24. Such control signals can include, for example, signals to turn the camera unit 22 on/off and signals to change parameters of the camera unit 22, such as exposure, gain, white balance, color saturation, brightness, hue, etc. These control signals are sent from the remote station 26 and received by a receive unit 60, which can include the antenna unit 36 and other components to process the received signals (e.g., a demodulator). The receive unit 60 can subsequently provide the control signals to a control unit 62 (or directly to the processing unit 56), so that the control signals can initiate change(s) in parameters of the camera unit 22. In one embodiment, the transmit unit 58 and the receive unit 60 can be separate components, while in another embodiment, they can form part of a single transceiver unit.

In conclusion, an embodiment of the invention provides the camera unit 22 that utilizes existing physical characteristics of the helmet 12, thereby dramatically reducing the amount of changes that need to be done to the helmet 12 for mounting. Because of the small size of the camera unit 22 and the manner in which it is mounted, the possibility of causing injury to the wearer or to other players so is reduced. In one embodiment, the camera unit 22 uses the existing face mask 18 for the mounting foundation. The mounting mechanism includes a tilting adjustment unit 48 to allow the camera unit 22 to be adjusted for each individual wearer and to the variances in physical characteristics of individual helmets 12. The camera unit 22 comprises a fully integrated camera module of such small size and weight that minimizes intrusiveness to the wearer to the point that camera use is made feasible for modern-day sporting activities.

The above description of illustrated embodiments of the invention, including what is described in the Abstract, is not intended to be exhaustive or to limit the invention to the precise forms disclosed. While specific embodiments of, and examples for, the invention are described herein for illustrative purposes, various equivalent modifications are possible within the scope of the invention, as those skilled in the relevant art will recognize.

For example, while an embodiment has been described herein as including most or all of the components shown in Figure 4 on a single chip, it is possible to provide other embodiments where such components need not be located on a single chip. In these other embodiments, such components can instead be separate elements coupled together and mounted on the substrate 28.

In other modifications, the camera unit 22 can be mounted on helmets other than football helmets. In these other types of helmets, the camera unit 22 can be mounted on face masks, face guards, bills, or other suitable structures, including on the exterior surface of the helmets themselves. Furthermore, while an embodiment has been described herein as having the camera unit 22 mounted onto the helmet 12, it is possible to provide other embodiments where the camera unit 22 is made an integral part of the helmet 12. Because of the small size of the components of the camera unit 22, the camera unit 22 (or at least a portion thereof) easily can be made integral with the structure of the main body 14 at the front region of the helmet 12. This may be done, for example, during the manufacturing or assembly process for the helmet 12.

These modifications can be made to the invention in light of the above detailed description. The terms used in the following claims should not be construed to limit the invention to the specific embodiments disclosed in the specification and the claims. Rather, the scope of the invention is to be determined entirely by the

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